UNIQUE MEIOTIC BEHAVIOUR IN F₁ PLANTS FROM
A CROSS BETWEEN A NON-TUBEROUS AND A
TUBEROUS SOLANUM SPECIES IN SECTION PETOTA

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ABSTRACT

Uniformly abnormal meiotic behaviour was observed in 12 F₁-plants from a cross between Solanum etuberosum (non-tuberous) and S. pinnatisectum (tuberous). Per pollen mother cell at MI an average was found of 3.64 bivalents (all rodshaped, 1–2 per cell, heteromorphic), 16.64 univalents (scattered haphazardly on a continuous bipolar spindle) and 0.03 trivalents (all Y-shaped). Lagging chromosomes and precocious division of univalents very frequently occurs, leading to unequal distribution of chromosomes, aneuploid gametes and male sterility. Heteromorphic bivalents at MI, loops in bivalents at pachytene and non-disjunction in one hybrid plant, point to a highly abnormal meiotic behaviour. The occurrence of few trivalents is discussed.

Considering that according to the literature nearly normal pairing was observed in the intergeneric F₁-hybrids Lycopersicon esculentum × Solanum lycopersicoides and L. esculentum × S. pennellii, the lack of chromosome pairing in an interspecific F₁-hybrid, of which both Solanum parents belong to the same section, is paradoxical to a plant breeder and might even be conspicuous to a taxonomist.

INTRODUCTION

In a previous publication HERMSEN & TAYLOR (1978) described the results of intercrossing 10 tuber-bearing Solanum species of section Petota (HAWKES, 1978; formerly subsection Hyperbasarthrum) with the non-tuberous species S. brevidens and S. etuberosum belonging to the same section. Only the cross between S. etuberosum and S. pinnatisectum was successful, and the aforementioned authors discussed its significance for physiological, phylogenetic and breeding research.

So far as investigated chromosome pairing in interspecific hybrids in tuberbearing Solanum is rarely inhibited and if inhibition occurs it is always slight. Hitherto hybrids of non-tuberous and tuberous Solanum species could hardly be obtained and meiosis has never been studied before. So it was tempting to carry out a careful analysis of meiosis in S. etuberosum, S. pinnatisectum and their hybrid plants.

MATERIAL AND METHODS

In 1978 fifty-three hybrid plants were raised, 13 of them being put under short-day conditions (12 h daylength). Of the remaining ones 50% (the plant numbers EP1–EP20) were grafted onto tomato for extensive further crossings. Also the material for cytologi-
cal studies was taken from these grafts (except EP38). The code EP stands for *S. etuberosum* × *S. pinnatisectum*. The vigorous highly branching hybrids flowered profusely and the conditions were favourable for analysis of meiosis.

Young flower buds were fixed in a solution of propionic acid (saturated with ferric acetate) and ethyl alcohol for 48 hours. Anthers with suitable stages were squashed in a drop of 1% acetocarmine according to the usual procedures. Observations were made from the temporary slides, and some were made permanent.

**RESULTS**

Meiosis was examined in 8 of the hybrid plants. Except for some minor variation, which will be pointed out later, all these plants have uniformly abnormal meiosis. Therefore, the general features of meiosis that are common to all the hybrid plants studied are described below.

The earliest stage of meiosis that could be observed was pachytene. In general it was extremely difficult to obtain analysable preparations of this stage. This was because of the lack of chromosome pairing, the delicate univalent threads getting entangled due to fixation. Only in exceptional cases paired structures representing bivalents were visible, but the number of such paired structures per cell could not be estimated. Although completely paired bivalents were observed in some cases, small structural differences in the heterochromatic parts of pachytene bivalents could be detected (Figs. 1 and 2). These unpaired heterochromatic parts are similar to those observed in intergeneric hybrids between *Lycopersicon esculentum* × *S. lycopersicoides* (MENZEL, 1962) and *L. esculentum* × *S. pennellii* (KHUSH & RICK, 1963).

Since a trivalent was observed at later stages of meiosis (see below), an attempt was made to detect multivalent configuration at pachytene stage (Fig. 3 and 3a). The structure indicated in Fig. 3 only illustrates the fact that more than two chromosomes can be involved in a pairing configuration, but it need not necessarily represent the trivalent that is observed at metaphase I.

Following the pachytene stage the usual diplotene and diakinesis are observed but these stages appear to be too transient and therefore too difficult to obtain in large numbers of cells for the analysis of chromosome associations. Nevertheless, a low degree of chromosome pairing is evident already at diakinesis. The presence of highly condensed, but still rod-shaped univalents, and the presence of a nucleus (Fig. 4) characterise diakinesis.

At metaphase I a large number of univalents (10–24), a few bivalents (1–7) and a very low frequency of trivalents were observed (Figs. 5–7). The chromosome associations recorded in individual hybrid plants are given in Table 1. Of the large number of bivalents observed, none had more than one chiasma, i.e. all were rod-bivalents, and 1–2 bivalents/cell were in many cases clearly heteromorphic (Fig. 5). The trivalents were a Y-shaped structure (Fig. 7), but never a chain of three.

Although the bivalents have a tendency to orient themselves on the equatorial plate the univalents are scattered haphazardly on a continuous bipolar spindle (Fig. 6). This abnormal arrangement of univalents on the spindle leads to a highly irregular and unbalanced separation of chromosomes to the poles at anaphase I, and very frequently a large number of univalents lag and divide precociously (Fig. 8). The unbalanced chro-